The present invention concerns a method for channel allocation in an ad-hoc radio communication system comprising devices having an equivalent communication architecture, the devices being gathered in several piconets, the devices of a same piconet being able to communicate with one another, a piconet coordinator (PNC) being defined among the devices for each piconet, the multiple access scheme for the radio communication between the devices being a Code Division Multiple Access (CDMA) scheme.

The invention is particularly suitable in local radio network like an office network linking computers, printers, DVD readers, video recorder and TV.

In cellular networks, communications control is centralized at a point known as a base station. The base station is characterized by a particular architecture.

On the contrary, in an ad-hoc network, all devices have an equivalent communication architecture and have peer-to-peer communication. Specific protocols have to be set up for networking and connecting between two devices.

The 802.15.3 system is currently standardized in IEEE. This standard provides an ad-hoc network but with a centralized access in each elementary network which is called a piconet. A Piconet Coordinator (PNC) takes the role of central controller inside each piconet. The associated piconet extends approximately 10 m around the piconet coordinator. Hence, the piconet coordinator is responsible for allocating to the devices of its piconet the resources necessary for their communications. The multiple access technique used in such systems is Time Division Multiple Access (TDMA). The separation of piconets is obtained through frequency division. Two neighbouring piconets use two different frequency bands.

A new physical layer is currently proposed to reach even higher bit rates than in 802.15.3. That new physical layer is known by the acronym UWB for Ultra Wide Band. This new physical layer is planed to be associated with a multiple access technique based on code division (CDMA).

The aim of the invention is to provide a method for channel allocation in an ad-hoc network with CDMA multiple access scheme.

Accordingly, the subject-matter of the invention is a method for channel allocation in an ad-hoc radio communication system, as defined in claim 1.

According to particular embodiments, the method comprising the features of one or more sub-claims.

The invention will be better understood on reading the description which follows, given merely by way of example and while referring to the drawings in which :

- figure 1 is a schematic view of an ad-hoc radio communication system according to the invention ;
- figure 2 is a table stored in each device of the ad-hoc radio communication system ;
- figure 3 is a flow chart explaining the method for channel allocation for a new device in an ad-hoc radio communication system according to the invention ; and
- figure 4 is a chart explaining the messages sent between devices of a piconet when a new device joins an existing piconet.

Figure 1 shows an ad-hoc radio communication system which is assumed to be based on IEEE 802.15.3 standard, except for the additional features which are provided by the invention.

The system includes several devices which have an equivalent communication architecture. All of them are adapted to send and receive messages through radio links.

The devices are, for example, computers, printers, cameras and recorders.

The devices are gathered in piconets. All the devices contained in a same piconet are able to communicate with one another. Four piconets 1, 2, 3, 4 are shown on figure 1. Each piconet includes a piconet coordinator PNC denoted by 11, 12, 13 and 14.

The way each piconet coordinator is defined among the devices of a piconet is explained hereafter.

Each piconet includes other devices 21, 22, 23, 24 which are not piconet coordinator and which are adapted to communicate with one another and with their associated piconet coordinator 11, 12, 13, 14.

The multiple access scheme for the radio communication between the ad-hoc radio communication system devices is a Code Division Multiple Access scheme (CDMA) scheme.

It is considered that a set C of N_c codes is available for channel allocation. For example $N_c = 100$. C is divided into n subsets C_i, $i \in \{1,\ldots,n\}$. For example n = 5.

According to the invention, each subset C_i is allocated to each piconet.

In each subset C_i, one code denoted C_i^{bc} is used for broadcast only. Another code denoted C_i^{RACH} is used for random access only. The other codes denoted C_i^j are used for reception of data by a particular device j of the piconet.

All the system devices have a pre-knowledge of the subsets C_i and especially of C_i^{bc} and C_i^{RACH}.

Thus, each device includes a memory, like a Read Only Memory in which all the available codes are stored.

More precisely and as shown on figure 2, the memory of each device includes a table which contains, for each subset of codes C_i, the broadcast code C_i^{bc}, the random access code C_i^{RACH} and the reception codes C_i^j. In addition, a short address on 8 bits is associated to each code. This address corresponds to a pointer which is an indication of the associated code.

According to the invention, all the devices of a same piconet use the codes of the same subset of codes for the communication. Thus, a subset of codes C_i is associated to each piconet i. The subset of adjacent piconets can be different or not. Advantageously, they are different.

In a piconet, the piconet coordinator periodically broadcasts general information to all the devices of the piconet using the broadcast code C_i^{bc}. Since the C_i^{bc} code is known by each device of the piconet, the general information are received and considered by all the devices.

The C_i^{RACH} is used by a device of the piconet or a new device intending to join the piconet in order to send a message to the piconet coordinator.

A reception code C_i^j is associated to each device j of the piconet. This code is used by the devices of the piconet for encoding a message when they intend to send a message to the particular device j.

The piconets are created step by step, each time a new device is added in the ad-hoc radio communication system.

The method for channel allocation will now be disclosed with reference to figures 3 and 4.

When a new device is added, it tries to join an existing piconet. In this aim, it first listens to its radio environment.

Referring to figure 3, at step 100, the new device listens successively to all the broadcast codes C_i^{bc}, $i \in \{1,\dots,n\}$ which could have been broadcasted by the piconet coordinators as shown by M1 on figure 4. If none of these codes is detected, it selects randomly a used subset of codes C_k, at step 102, and starts to broadcast information on the associated broadcast code C_k^{bc}, at step 104. Thus, the new device becomes a piconet coordinator and creates its own piconet.

In the case where one or several broadcast codes C_i^{bc} have been detected, the new device determines, at step 106, if some piconets are available to receive it.

More precisely, it determines for each piconet, if this piconet is able to correctly work with an additional device.

To determine the availability of a piconet, a criteria based on the load of the piconet is applied. The measure for the load of the piconet is carried out by the new device and the measured load is compared to a overload thresold. A set of available piconets is thus determined.

If the set of available piconets is empty, which means that all the detected piconets are overloaded, a subset of codes C_k different from those dedicated to the detected piconets is selected, at step 108.

Information are then broadcasted by the new device using the broadcast code C_k^{bc} of the selected subset C_k. A new piconet k is created, and the new device is the piconet coordinator of the new piconet.

If the set of available piconets contains more than two piconets, the new device classifies them according to a predetermined criteria. In a preferred embodiment, this criteria is the radio quality.

At step 112, it selects the piconet having the best result according to the applied criteria. In the present case, the selected piconet is the one with the best reception quality.

If there is a single piconet in the set of available piconets, this piconet is selected to be joined by the new device.

At step 114, the new device determines the subset of codes C_k used in the selected piconet from the broadcast code C_k^{bc} which has been listened. Since the subset of codes is memorised in the device, it determines the random access code C_k^{RACH}.

From that point, a network attachment procedure is implemented. The messages sent are illustrated on figure 4.

At step 116, the new device sends an attachment request message M2 by using the random access code C_k^{RACH}. The attachment request message M2 includes attributes relating to the new device. These attributes are for example the IP address, the type and the functionalities of the new device.

The piconet coordinator decides then according to available resources to accept or not the new device in the piconet. In the positive case, it attributes a short address on 8 bits to the new device as in the 802.15.3 system, at step 118. That address corresponds to the reception code C_k^j and is used as a pointer to a reception code C_k^j to be used by the new device for reception of data.

The address is sent in an attachment response M3 which is broadcasted on C_k^{bc} code.

At step 120, the piconet coordinator then broadcasts information M4 concerning the new device j joining the piconet to all the other devices of the piconet. The information are sent by using the broadcast code C_k^{bc}. The information include the attributes such as the IP address, the type and the functionalities of the new device together with its short address corresponding to its reception code C_k^j. Thus, all the devices of the piconet can then

determine from the short address the code C_k^j to use to get in communication with the new device.

After having joined a piconet, a device periodically listens to its reception code C_k^j.

If a device B wants to send some data to another device C in a same piconet i, device B listens to the broadcast code C_i^{bc} of the piconet to determine the reception code C_i^C for device C and the attributes of device C.

Device B sends then a connection request message to device C by using the reception code C_i^C of device C. The connection request message contains a attributes relating to expected receiving device C so that device C can determine whether it is the actual expected destination. These attributes are for example a piconet identifier or a functionality of the expected receiving device C such as the type of expected receiver.

Device C considers and processes the following data sent by device B only, if the attributes contained in the connection request message actually relating to it. On reception of a connection request message containing attributes relating to it, device C sends an acknowledgement message to device B informing device B that the following data can be sent and will be processed by it.

Such an identification process is useful for avoiding two devices from two different piconets which have the same reception code to process the sent data. Indeed, nothing can guarantee that two neighbouring piconets do not use the same subset of codes.